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Report to Congressional Requesters

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AVIATION

FAA's Use and Management of Communications Resources

GAO

United States
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Information Management and
Technology Division

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The Honorable Frank R. Lautenberg
Chairman, Subcommittee on Transportation
and Related Agencies
Committee on Appropriations
United States Senate

The Honorable William Lehman
Chairman, Subcommittee on Transportation
and Related Agencies
Committee on Appropriations
House of Representatives

In response to your request, we identified the Federal Aviation Administration's (FAA) data and voice communications resources. As agreed with your offices, our objectives were to (1) identify FAA's communications systems, including their functions and costs, and (2) identify the agency's organizations that manage the operation and acquisition of communications. A detailed explanation of our objectives, scope, and methodology is contained in appendix I.

Results in Brief

Communications are vital to FAA, especially in fulfilling its mission to promote the safe, orderly, and expeditious flow of air traffic. Agency communications, consisting of transmission systems and the equipment necessary to connect information senders and receivers, are numerous and diverse and must be carefully planned, procured, managed, and maintained. In addition to annually leasing over $200 million in communications, FAA estimates that from 1982 through the 1990s, $2.7 billion will be needed to develop and purchase communications. With FAA's move toward greater ownership of communications, it is critical that FAA carefully manage and control these resources.

Although FAA established in 1987 an organization to centralize its management of communications, this entity does not have control over many key communications functions. These functions, such as systems engineering, procurement and deployment of owned resources, and real-time operations and maintenance,[1] are the responsibility of several other agency components. Further, these other components exercise their

[1]Real-time operations and maintenance includes restoring service in the event of outages, circuit and equipment repair, and performance monitoring and reporting.

communications responsibilities without defined procedures for coordinating their activities with the central organization. Without greater consolidation of communications responsibilities or sufficient coordination, significant equipment compatibility, system integration, and network monitoring and control problems can result.

FAA recognizes the adverse consequences of these potential problems and therefore is considering improvements in how it manages its communications, as part of its development of a new strategic telecommunications plan. Timely completion of this plan should assist FAA in effectively controlling these critical resources.

Background

FAA communications support air traffic control systems, interfacility systems, maintenance and operations support programs, and administrative systems. Communications services provide data and voice communications among facilities and between facilities and aircraft in support of the busiest and most complex air traffic control system in the world, FAA's National Airspace System (NAS).

FAA communications consist of transmission media and the equipment required to connect users. Transmission media include leased paths from common carriers or local telephone companies, FAA-owned cabling at airports and facilities, and FAA-owned microwave transmission systems. Equipment includes radio transmitters, receivers, antennae, modems, multiplexers,[2] control equipment, telephones, data terminals, and switching systems.[3]

Changing Environment Leads to Increased Ownership of Communications

In 1981, FAA chartered a comprehensive NAS Plan for modernizing and improving air traffic control and airway facilities services. FAA is currently implementing this plan to improve safety, reliability, and efficiency. These improvements are to be accomplished using extensive automation and more communications than have been used in the past.

Also in the early 1980s, FAA predicted future substantial increases in commercial communications leasing rates. According to FAA officials, lease costs for communications were relatively stable prior to 1980.

[2]Multiplexers consolidate data from multiple lower-speed communications lines onto a single high-speed communications line for more economical transmission.

[3]A switching system receives voice and data signals and routes the signals to the appropriate destinations.

Communications services were primarily leased from American Telephone and Telegraph Company (AT&T) and service problems could be identified and remedied primarily by that one vendor. However, with the AT&T divestiture and the deregulation of communications activities, the agency projected a dramatic increase in the cost to lease transmission lines. Further, with a greater number of communications vendors providing services, it was more difficult to identify responsibility for service failures.

In response to these changes, FAA decided to increase its ownership of communications resources. This increased ownership will require the agency to function much like a telephone company by owning, operating, and managing systems supporting a variety of NAS voice and data communications services.

Communications Services and Projects

NAS includes over 4400 facilities nationwide, all of which require some form of communications capability. At these facilities a variety of functions are performed ranging from separating aircraft to aiding navigation. To support these functions and its administrative activities, FAA has 63 communications services. Appendix II describes each of these services. In fiscal year 1988, the agency spent over $218 million of its operations appropriation to lease resources for these services. FAA estimates that from 1982 through the 1990s, $2.7 billion will be needed in Facilities and Equipment (F&E) and Research, Engineering, and Development (RE&D) funds to develop and purchase communications.[4]

FAA categorizes air traffic control facilities by the functions they perform and the defined boundaries of the airspace they are responsible for controlling. Each of these types of facilities—en route, terminal, and flight service station—requires a significant amount of communications support.

En route facilities include air route traffic control centers, which control aircraft en route between airports in airspace generally above 10,000 feet that are not under the control of military or other facilities. These

[4]FAA communications are funded under different appropriations categories. Funding necessary to modernize and improve air traffic control and airway facilities is obtained from the F&E appropriation. Owned communications projects are included under this appropriation. Funding necessary to provide for the daily operations and maintenance of air traffic systems and administrative systems is obtained from the operations appropriation. All leased communications resources are funded through the operations appropriation. FAA also conducts research, engineering, and development programs to apply new technologies to meet air traffic control requirements. These programs are funded through the RE&D appropriation.

centers provide separation service, traffic advisories, and weather information to pilots. Terminal facilities include airport traffic control towers that control aircraft in the airspace that immediately surrounds the airports and on the ground, and terminal radar approach control facilities that control the aircraft in the approach zones of the airspace surrounding airports. Flight service stations provide a range of services such as flight plan filing, preflight and in-flight weather briefings, and assistance to pilots in distress. FAA has 42 communications services that support the en route, terminal, and flight service station facilities.

In addition to the services directly supporting the above three types of facilities, FAA has the following communications services:

- Seven interfacility communications services support all of the communications requirements between facilities, including manned facilities such as en route centers, and unmanned facilities such as radars and ground-to-air radio sites.
- Eleven communications services provide mission-based administrative, maintenance, and operations support. Included are buildings, plants, laboratory facilities, all maintenance operations, flight inspections, and emergency programs.
- Three communications services are for agency administrative needs. These services provide connections between FAA headquarters, regional offices, and other federal organizations to conduct agency business such as exchanging personnel and payroll information.

FAA-Owned Communications Will Be Extensive

While most of its communications resources are leased, FAA has begun buying more communications. Currently, it has 20 F&E and RE&D funded projects in varying stages of development and implementation for communications networks, switching systems, equipment, and support initiatives. These 20 projects are to replace and upgrade existing equipment, provide new and expanded capability, or provide for better management and support of communications resources and facilities. When completed, most of these will become components of the communications services described above. Appendix III describes each of these 20 communications projects.

FAA's Approach to Communications Management Is Evolving

FAA's communications functions are managed and directed by several different organizations. FAA established a centralized management structure in 1987; however, other separate organizations are responsible for procurements and deployments, real-time operations and maintenance, and overall system engineering. FAA has not defined how these separate organizations are to work with the centralized communications structure, resulting in potential problems with equipment compatibility, effective system integration, and network monitoring and control. However, FAA recognizes that these potential problems could emerge, and is therefore studying ways to more effectively manage communications.

FAA Establishes Centralized Organization

In an effort to improve the agency's management of communications, in October 1987 FAA established a centralized communications management organization in headquarters called the Telecommunications Management and Operations (TM&O) Division. Parallel organizations are to be in place in the regions by 1990. The TM&O Division was charged with responsibility for network planning and engineering, circuit engineering, network management, administration and budget of the leased program, data base management, configuration control, and regional coordination.

Many Agency Components Have Communications Responsibilities

Although some activities were consolidated with the establishment of the TM&O Division, many communications responsibilities remain with several other organizational components. For example, a separate organization has responsibility for the development, procurement, site preparation, and deployment of most NAS capital investment acquisitions, including communications resources. However, communications projects requiring extensive research, engineering, and development are developed, procured, and deployed by another FAA organization with responsibility for technically complex NAS Plan systems. In addition, while TM&O has responsibility for communications network planning and engineering, overall NAS systems engineering responsibility, which includes communications systems, is assigned to a separate organization. Furthermore, responsibilities for real-time communications operations and maintenance functions are handled by separate organizations.

Although the TM&O Division has responsibility for administering and budgeting leased communications resources, the Defense Commercial Communications Office does the actual procuring of the majority of leased resources. This relationship was established in the early 1960s to promote economy in acquiring leased transmission and equipment and

for coordination in meeting joint national security communications requirements.

FAA Is Aware of Potential Problems

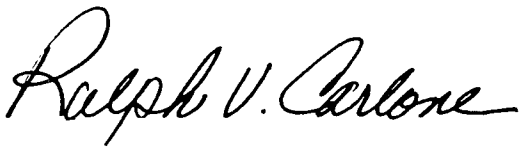
Although FAA defined TM&O responsibilities when this new division was established, it did not determine how other organizations with communications responsibilities were to work with TM&O to ensure effective coordination. Without effective coordination between agency components, potential problems can result, such as:

- Equipment leased by the TM&O may not be compatible with owned equipment purchased by another entity.
- Network engineering, which is the responsibility of the TM&O division, can overlap with systems engineering, which is the responsibility of another organization. Thus, systems integration difficulties can arise. For example, changes to communications networks such as expansions, consolidations, or the introduction of new technologies can have a significant impact on overall system design and system requirements specifications.
- Communications networks may not be effectively managed, monitored, and controlled because real-time operations and maintenance functions are performed independent of network planning, engineering, configuration control, and data base management functions.

Agency officials recognize these potential problems and are therefore currently considering ways to better manage communications, as part of their development of an agency strategic telecommunications plan. Among the potential improvements being considered are (1) establishing one entity that would be responsible for satisfying all agency communications requirements including systems engineering and real-time maintenance functions, and (2) defining and strengthening the relationships between the TM&O division and the divisions responsible for systems engineering, communications projects, and maintenance. According to the TM&O division director, a draft strategic telecommunications plan is currently being reviewed by various agency organizations with expected final issuance by May 1990. Timely completion of this plan should assist FAA in managing communications effectively.

We obtained Department of Transportation and FAA officials' views on this report and incorporated their comments as appropriate. As arranged with your office, we are sending copies of this report to the Secretary of Transportation, the FAA Administrator, and other interested

parties, and will make copies available to others upon request. This report was prepared under the direction of JayEtta Z. Hecker, Director, Resources, Community, and Economic Development Information Systems, (202) 275-9675. Other major contributors are listed in appendix IV.



Ralph V. Carlone
Assistant Comptroller General

Contents

Abbreviations

AT&T	American Telephone and Telegraph Company
FAA	Federal Aviation Administration
F&E	Facilities and Equipment
GAO	General Accounting Office
IMTEC	Information Management and Technology Division
NAS	National Airspace System
RE&D	Research, Engineering, and Development
TM&O	Telecommunications Management and Operations Division

Objectives, Scope, and Methodology

At the request of the House and Senate Appropriations Committees, Subcommittees on Transportation and Related Agencies, we identified the Federal Aviation Administration's (FAA) communications resources. Our objectives were to (1) identify communications systems and ascertain their functions and costs, and (2) identify the agency's organizations that manage the operation and acquisition of communications resources.

To accomplish these objectives, we gathered descriptive information on FAA communications services, supporting resources, and associated costs; FAA's communications management and acquisition processes; and planned communications projects. We examined key communications documents such as current and future telecommunications plans, the National Airspace System (NAS) Plan, budget submissions, contractor reports, and telecommunications management and operations studies. We met with FAA headquarters and regional officials responsible for communications requirements formulation, budgeting, acquisition, management, and operations to discuss their efforts in these areas. We also discussed communications planning efforts with Martin Marietta, the contractor responsible for NAS systems engineering and integration.

Our work was performed from November 1988 to December 1989 at FAA headquarters, Martin Marietta, and MSI Services, Inc., in Washington, D.C.; and at FAA's Eastern Regional Office, in New York, New York. We obtained Department of Transportation and FAA officials' views on this report and have incorporated their comments where appropriate. We conducted our review in accordance with generally accepted government auditing standards.

FAA Communications Services

The National Airspace System (NAS) includes approximately 4,430 major facilities nationwide, all of which require some form of communications capability. These facilities provide a variety of services that allow FAA to provide for the safe, orderly, and expeditious flow of civilian and military air traffic.

FAA categorizes air traffic control facilities by the functions and services they perform and the defined boundaries of the airspace they are responsible for controlling. These categories—en route, terminal, and flight service station—each require a significant amount of communications support. En route facilities consist of air route traffic control centers, which generally control aircraft en route between airports not under the control of the military or other facilities. These centers provide separation service, traffic advisories, and weather information to pilots en route between airports. Terminal facilities consist of air traffic control towers, which control aircraft in the airspace that immediately surrounds airports and aircraft on the ground, and Terminal Radar Approach Control facilities, which control the aircraft in the approach zones of the airspace surrounding airports. Flight service stations provide several services such as flight plan filing, preflight and inflight weather briefings, and assistance to pilots in distress. FAA also maintains radar installations, remote radio sites, and navigational aid locations.

In addition to the communications supporting these air traffic control functions, FAA has communications, known as communications utilities, which allow facilities to exchange information with each other. FAA also has communications that support the NAS and agency administrative operations that are categorized as other services communications and administrative communications, respectively.

FAA communications consist of both leased and owned transmission media and equipment. The bulk of these resources are leased, and incurred costs of over $200 million in fiscal year 1988. Table II.1 lists each service category, the number of services in each, and their fiscal year 1988 lease costs funded through the operations appropriation.

Table II.1: FAA Communications Service Categories

Service Category	Number of Services	Fiscal Year 1988 Lease Costs
En Route Communications	12	$74,683,382
Terminal Communications	12	21,654,543
Flight Service Station Communications	18	64,895,651
Communications Utilities	7	11,969,253
Other Services Communications	11	19,178,171
Administrative Communications	3	26,385,510
Total	**63**	**$218,766,510**

En Route Communications

En route communications consist of voice and data communications assisting in air traffic control of en route aircraft between airports that are not under the control of military or terminal facilities. Examples of this type of communications are air-to-ground radio systems used for communication between air traffic controllers and pilots, and radar and beacon systems used to identify aircraft. Table II.2 lists the 12 en route services with their fiscal year 1988 lease costs. A brief description of each en route communications service follows.

Table II. 2: En Route Communications

Service	Fiscal Year 1988 Lease Costs
En Route Equipment Systems	$21,632,763
En Route Communications	18,006,048
Service F Interphone: Center to Center and Center to Non-Center (two services)	15,980,879
Aeronautical Radio, Inc.	9,058,000
En Route Navigational Aids	6,032,459
En Route Radar Digitized Data	1,458,450
Central Flow Control Service	1,187,118
Interfacility Data Service	963,998
En Route Beacon Digitized Data	233,703
En Route Broadband Radar and En Route Broadband Secondary Radar Beacon (two services)	129,964
Total	**$74,683,382**

En Route Equipment Systems

These systems allow en route controllers access to voice communications within air route traffic control centers and outside to towers, flight service stations, central flow control, and military locations. These systems consist of switches and associated equipment.

En Route Communications	This service provides voice communications between air traffic controllers and en route aircraft. It consists of leased circuits and associated equipment, transmitters, receivers, and switches.
Service F Interphone: Center to Center and Center to Non-Center	The Service F Interphone is a comprehensive, nationwide voice system that interconnects FAA facilities, military air traffic control, the National Weather Service, the Coast Guard, and some nongovernment aviation facilities. The interphone service is used for transferring flight information between controllers and facilities, coordinating flight plan and flight movement, and managing traffic flows in high density areas. The center-to-center component consists of voice circuits and associated equipment connecting air route traffic control centers. The center to non-center component consists of voice circuits and associated equipment connecting an air route traffic control center and other FAA facilities such as a tower.
Aeronautical Radio, Inc.	This is a commercial communications corporation that designs, constructs, operates, leases, and engages in radio activities serving the aviation community. For example, it provides direct pilot and controller contact with civil and military aircraft flying in oceanic airspace over high-frequency radio.
En Route Navigational Aids	This service provides guidance and/or position data to in-flight aircraft operating between terminals. It consists of leased circuits and associated equipment that allow navigational signals to be transmitted to aircraft.
En Route Radar Digitized Data	This service provides controllers with radar data on the position of en route aircraft operating between terminals. It consists of narrowband radar circuits, modems, and associated equipment.
Central Flow Control Service	This service is a voice and data flow control system used to monitor the overall demand on the air traffic system. It consists of leased circuits, switches, modems, and associated equipment.
Interfacility Data Service	This service is used to exchange data between air route traffic control centers and interfacility data system sites, towers, and other air route

traffic control centers. It consists of computer circuits, modems, and associated equipment.

En Route Beacon Digitized Data

A variety of leased radar circuits and associated equipment comprise this service, which is used to obtain aircraft information, such as aircraft identification and altitude.

En Route Broadband Radar and En Route Broadband Secondary Radar Beacon

The first service provides controllers with a video map radar display, and the second provides a graphic display of beacon radar information through circuits and associated equipment. Together, these two services also serve as a back-up for the processing of digitized data for computers in air route traffic control centers.

Terminal Communications

Terminal voice and data communications assist in providing air traffic control and navigational aid services for arriving and departing aircraft. Communications are used to separate aircraft, sequence aircraft into traffic patterns, and provide clearance and weather information to pilots in terminal airspace and on the ground. Examples of leased equipment include radio equipment for communications to aircraft; interphone communications to other facilities; and a variety of equipment for observing, detecting, receiving, and displaying weather information. Table II.3 lists the 12 terminal services with their fiscal year 1988 lease costs. A brief description of each of the terminal communications services follows.

Table II.3: Terminal Communications

Service	Fiscal Year 1988 Lease Costs
Terminal Equipment Systems	$12,935,690
Service F Interphone: Non-Center to Non-Center	3,626,426
Terminal Communications	2,774,949
Terminal Navigational Aids	1,013,868
Flight Data Entry and Printout Service and Flight Data Service	911,771
Terminal Radar Service, Terminal Automated Radar Service, and Terminal Secondary Radar Service (three services)	220,294
Visual Navigational Aids	96,565
Remote Tower Alphanumerics Display and Remote Tower Radar Display (two services)	56,031
Automatic Terminal Information Service	18,949
Total	**$21,654,543**

Terminal Equipment Systems	These systems allow controllers to select various communications paths and to direct communications to desired locations, such as other controllers within a facility, controllers at other facilities, aircraft, and other locations. The systems consist of switches and interphone key equipment.
Service F Interphone: Nonair Route Traffic Control Center to Nonair Route Traffic Control Center	The Service F Interphone is a comprehensive, nationwide voice system that connects FAA facilities, military air traffic control, the National Weather Service, the Coast Guard, and some nongovernment aviation facilities. This component connects nonair route traffic control center facilities, such as towers and flight service stations, and is used to transfer flight information between controllers and facilities, coordinate flight plan and flight movement information, and manage traffic flows in high density areas. This component consists of voice circuits and associated equipment between two nonair route traffic control centers.
Terminal Communications	This service provides air-to-ground voice communications between terminal air traffic control facilities and pilots. It consists of circuits, radios, transmitters, receivers, and associated equipment.
Terminal Navigational Aids	This service provides for the monitoring and control of navigational aids as well as voice modulation capabilities. It consists of terminal instrument landing systems and noninstrument landing systems, navigational aids circuits, and associated equipment such as locators and markers.
Flight Data Entry and Printout Service and Flight Data Service	This service enables terminal facilities and air route traffic control centers to exchange and process flight data information. This service consists of data circuits, modems, and associated equipment.
Terminal Radar Service, Terminal Automated Radar Service, and Terminal Secondary Radar Service	These three services provide different types of radar data that are displayed in terminal control or tower facilities. These services allow controllers to follow an aircraft's flight path, give traffic advisories, maintain separation, and sequence landings and take-offs. They consist of primary radar, secondary radar, remote radar, and computer circuits.

Visual Navigational Aids

This service controls systems by turning lighting off and on, setting the brightness, and monitoring outputs. It consists of airport lighting circuits and visual navigational aids such as approach lighting systems, runway lighting systems, airport lighting systems, runway identification lights, rotating beacons, and associated equipment.

Remote Tower Alphanumerics Display and Remote Tower Radar Display

The remote tower alphanumerics display provides terminal control facilities with alphanumeric aircraft radar data and processing information. The remote tower radar display provides remote air traffic control tower facilities with primary radar and/or beacon aircraft data. Together, these services provide control and advisory information, and consist of computer circuits, radar equipment, video display units, digitizers, modems, remote terminal radar circuits, radar equipment, and video display units.

Automatic Terminal Information Service

This service continuously broadcasts recorded information to pilots on items such as runways in use, weather conditions, visibility, wind velocity, and aircraft altitude settings. Most high-activity terminal areas use this service to reduce radio frequency congestion. It consists of recorders, radios, transmitters, receivers, and navigational aids.

Flight Service Station Communications

Flight service station communications provide a wide range of advisory and support services for aircraft operations. These services are used to transmit weather observations and airport advisories, assist pilots in distress, and advise customs and immigration officials of transborder flights. Table II.4 lists the 18 flight service station services with their fiscal year 1988 lease costs. A brief description of each service follows.

Table II.4: Flight Service Station Communications

Service	Fiscal Year 1988 Lease Costs
Service A Teletype: Domestic Weather Information	$772,215
Service B Teletype: Aircraft Movement Information	639,158
Leased A-B Service	23,907,188
Flight Service Station Equipment Systems	11,334,920
Pilot Briefing	9,970,678
Flight Service Station to Aircraft Radio Voice Communications	6,177,793
Interim Voice Response System	4,073,000
En Route Flight Advisory Service	2,005,377
Meteorological Information	1,699,523
Remote Radar Weather Display System	1,678,006
Direction Finding	956,852
Flight Service Automated Data	671,831
Aeronautical Fixed Telecommunications Network	448,532
Service O Teletype: International Meteorological Information	240,428
Automatic Weather Observation System	180,173
National Facsimile and Digital Facsimile Services (two services)	124,321
Service C Teletype: Domestic General Meteorological Information	15,656
Total	**$64,895,651**

Service a Teletype: Domestic Weather Information

This service collects aeronautical and weather information from the National Meteorological Center and distributes it to controllers. The service consists of circuits, teletype equipment, printers, and associated equipment.

Service B Teletype: Aircraft Movement Information

This service provides aircraft movement information to flight service stations and air traffic control centers and is used to transfer flight plans and flight plan amendments. It consists of low to medium speed circuits, teletype equipment, and associated equipment.

Leased A-B Service

This service provides the Service A Teletype and Service B Teletype services described above with higher speed lines. It consists of data circuits and associated equipment, including teleprinters.

Flight Service Station Equipment Systems

These systems perform routing, direction, and control functions for incoming and outgoing telecommunications at flight service stations and consist of switches and interphone key equipment.

Pilot Briefing	This is a telephone service that provides pilots with a preflight briefing on weather conditions, airports, and navigational aids. It also allows pilots to file a flight plan. The service consists of private line voice circuits, dial access circuits, and associated equipment.
Flight Service Station to Aircraft Radio Voice Communications	This service provides voice communications between flight service stations and in-flight aircraft. It consists of radios, transmitters, receivers, circuits, and associated equipment.
Interim Voice Response System	This is an interim computer network that continuously receives and stores aviation weather data, and upon request from any standard touchtone telephone, plays back recorded weather information.
En Route Flight Advisory Service	This service transmits pilot reports and en route real-time weather information from flight service stations to in-flight aircraft at or above 5,000 feet. It consists of transmitters, receivers, antennae, and circuits.
Meteorological Information	This service provides certain weather-related information not provided by any other service to FAA facilities. The service consists of data and dial-up circuits, electrowriters, and remote weather measuring equipment.
Remote Radar Weather Display System	The system provides a graphic display of National Weather Service radar information to flight service stations, air route traffic control centers, and FAA headquarters. The service consists of dial-up lines to National Weather Service radar, data circuits, radar display terminals, and associated equipment.
Direction Finding	This service allows flight service stations to determine the direction of a lost or distressed aircraft. It consists of circuits, remoting equipment, antennae, transmitters, and receivers.

Flight Service Automated Data	This service supplies weather and flight plan information to automated flight service stations and distributes it to selected air route traffic control centers. The service consists of data circuits, modems, and associated equipment.
Aeronautical Fixed Telecommunications Network	This network exchanges data, such as flight plans, weather data, distress messages, and some administrative messages, with the international aviation community. The network consists of circuits and associated equipment.
Service O Teletype: International Meteorological Information	This service provides the capability to exchange meteorological data between the United States and foreign nations, and is used by the National Weather Service, airlines, military, and air traffic control facilities. It consists of domestic and overseas fixed aeronautical teletype circuits and associated equipment.
Automatic Weather Observation System	This system gathers and analyzes meteorological data and makes it available to pilots via radio or telephone. The system consists of circuits, modems, weather sensors, and transmitters.
National Facsimile and Digital Facsimile Services	The National Facsimile Service provided weather-related information from the National Weather Service to flight service stations and air route traffic control centers through analog facsimile equipment, printers, and receivers. The Digital Facsimile Service recently replaced this service and consists of digital facsimile equipment, printers, leased satellite antennae, and receivers. According to FAA, the digital system will increase the speed of transmission and provide more graphics than were available on the analog service.
Service C Teletype: Domestic General Meteorological Information	This service carries specialized meteorological information to the National Weather Service, the military, airline forecast offices, and other special interests. It also carries all general public forecast products for widespread distribution by the press, radio, and television. It consists of circuits and teletype equipment.

Communications Utilities

Communications utilities are those systems that either support multiple, mission-oriented services or comprise a network covering a wide geographical area. Communications utilities include both leased and FAA-owned resources and provide transmission and switching services for voice and/or data communications. Table II.5 lists the seven data communications utilities with their fiscal year 1988 lease costs. A brief description of these communications services follows.

Table II.5: Communications Utilities

Service	Fiscal Year 1988 Lease Costs
Data Multiplexing Network	$8,930,544
Automatic Voice Network	1,356,047
Automatic Digital Network	893,576
National Airspace Data Interchange Network IA	722,866
Radio Communications Link	40,001
National Airspace Data Interchange Network II	14,954
Television Microwave Link	11,265
Total	**$11,969,253**

Data Multiplexing Network

This network connects several types of FAA facilities and provides various data on traffic management, domestic weather, and maintenance. The network consolidates data, by using multiplexing equipment, from several sources and transmits it over a single line.

Automatic Voice Network

This is a Department of Defense, dedicated voice telephone system used by FAA to coordinate commercial, civil, and military aviation and air traffic control matters. FAA is required to provide circuits and associated equipment to establish connection with the network.

Automatic Digital Network

This is a Department of Defense secure data communications system that allows FAA to exchange classified information with the Department of Defense, the Coast Guard, and various investigative, intelligence, and law enforcement agencies. FAA provides the circuits, switches, terminals, modems, and encryption devices necessary to connect FAA with the network.

National Airspace Data Interchange Network Ia

This message-switched[1] data network provides switching for flight plan data among flight service stations, air route traffic control centers, military base operations, and international ports. The network, consisting of switches and circuits, provides switching for domestic weather information and aircraft movement information.

Radio Communications Link

This service forms a national network between FAA facilities that provides an analog microwave transmission medium for voice, data, and broadband radar data traffic. This network consists of voice and data circuits and associated equipment to provide the transmission for many current services, such as broadband radar data, and future services, such as the Integrated Communications Switching System, and the Data Multiplexing Network.

National Airspace Data Interchange Network II

This is a packet switched[2] network that builds upon and expands the National Airspace Data Interchange Network IA. The network provides switching for flight plan data among flight service stations, air route traffic control centers, and military base operations. It will also provide switching for domestic weather information and aircraft movement. The network consists of packet switch nodes and circuits.

Television Microwave Link

This service transmits radar display information from terminal facilities to satellite air traffic control towers. It consists of circuits, microwave transmitters and receivers, dish antennae, cameras to create video displays, and other equipment.

Other Services Communications

Other services communications are those used to support mission-oriented services such as maintenance, monitoring systems, and training. Table II.6 lists these 11 services with their fiscal year 1988 lease costs. A brief description of each of the services follows.

[1]Message switching is a technique used to transmit data through a communications network using a message store and forward system. Rather than using a dedicated communications path, each message contains a destination address and is passed from source to destination through intermediate nodes. At each node the entire message is received, stored briefly, and then passed on to the next node.

[2]Packet switching is a method of transmitting messages through a communications network in which long messages are subdivided into short groups or packets. The packets are then transmitted from source to destination through intermediate nodes as in message switching. Packet switching is usually more efficient and rapid than message switching.

Table II.6: Other Services Communications

Service	Fiscal Year 1988 Lease Costs
Administrative Voice	$4,741,761
Service F Interphone: Miscellaneous	3,979,721
Administrative Equipment System	2,443,392
Staff Communications	1,597,345
Training	717,644
Remote Maintenance Monitoring System	662,693
Electronic Tandem Network	471,669
Emergency Voice Communication System	453,326
Administrative Data	56,697
National Radio Communications System	55,692
Miscellaneous	3,998,231
Total	**$19,178,171**

Administrative Voice

This service provides administrative voice communications within FAA facilities. It consists of circuits, telephones, private branch exchanges, and answering machines.

Service F Interphone: Miscellaneous

Unlike the Service F Interphone components previously described, this component consists of overseas and miscellaneous circuits and is used for interphone circuits that are not readily identified as the center-to-center, center-to-non-center, or non-center-to-non-center services described in previous categories.

Administrative Equipment System

This system provides switching and call handling capability for administrative communications at major air traffic control facilities. The system consists of a variety of switching equipment.

Staff Communications

This service is used by FAA personnel for normal day-to-day command and control operations as well as in cases of national emergency, disasters, aircraft accidents, and other distress situations. The Emergency Voice Communication System and Electronic Tandem Network discussed below are used as the transmission for this service.

Training

This service consists of information associated with the training of FAA personnel, and includes specialized equipment for controller training.

	The service consists of circuits, training equipment modems, multiplexing equipment, and associated equipment at major air traffic control facilities.
Remote Maintenance Monitoring System	This system provides centralized work stations with automated access to select FAA facilities. Equipment performance can be remotely monitored, controlled, and certified.
Electronic Tandem Network	This service is a secure network that links Emergency Voice Communication System nodes and is immune to overloads associated with disasters or holiday communications peaks. It uses private branch exchange tie lines, federal telecommunications system trunks, and direct long-distance dialing lines.
Emergency Voice Communication System	This system consists of private automated branch exchanges and other equipment, and uses the Electronic Tandem Network discussed above for transmission. The system is used to meet the national security and preparedness responsibilities for accidents, hijackings, security matters, military activities, and national disasters.
Administrative Data	This service allows administrative information to be transmitted between operational facilities. It consists of data circuits and associated equipment.
National Radio Communications System	This system has two objectives. Its primary objective is to provide minimum essential command and control communications capability to FAA, the Department of Transportation, and the Department of Defense during national, regional, or local emergencies. In an emergency when common carrier services are interrupted, the system supports the direction, management, operation, and reconstitution of NAS. During a national emergency such as a nuclear attack, the system is required to perform minimum essential communication functions in support of military wartime operations and essential civil air transportation. The system's secondary nonemergency objective is to provide day-to-day communications between regional headquarters and maintenance technicians. In addition, the system provides a communication system for flight check aircraft, crash site investigation teams, and aviation

security. Leased circuits and equipment at field facilities are used in the day-to-day operation portion of the system.

Miscellaneous

This service consists of equipment and circuits that are not categorized by any other service name or are temporarily in this category until appropriate services are assigned.

Administrative Communications

Administrative communications connect FAA headquarters, regional offices, field offices, and other federal organizations in order to conduct nonmission oriented agency business. Table II.7 lists the three administrative communications services with their fiscal year 1988 lease costs. A brief description of each of these services follows.

Table II.7: Administrative Communications

Service	Fiscal Year 1988 Lease Costs
Federal Telecommunications System	$15,806,510
Administrative Data Transmission Network	3,300,000
Other Administration	7,279,000a
Total	**$26,385,510**

[a]Includes both leased and purchased costs because FAA does not separately identify leased costs.

Federal Telecommunications System

This system is a nationwide, long-distance telephone service provided and managed by the General Services Administration for government offices. Agencies are billed according to usage at rates established by federal regulations.

Administrative Data Transmission Network

This is a partially encrypted, packet-switched network that transmits data from users to administrative host computers for a variety of systems including payroll, accounting, personnel management, aviation safety analysis, logistics and inventory, aviation management, and instrument approach procedures. The network also provides an agency-wide electronic mail service. According to agency officials, FAA is procuring this network under a lease-to-purchase contract, and is scheduled to own the network equipment in March 1991.

Other Administration

This service is divided into two accounts—working capital fund and regional distribution—which provide funding for various administrative telecommunications support services used throughout FAA and include both leased and purchased items. The working capital fund is for an FAA headquarters public branch exchange procurement project and for headquarters direct long-distance dialing. Regional distribution is for large administrative projects and regional direct long-distance dialing.

FAA Communications Projects

FAA currently has 20 active projects to procure or develop communications that will significantly increase the agency's owned resources. Planning for most of these projects began in the early 1980s and they represent a planned $2.7 billion dollar capital investment by FAA for communications resources through the 1990s. Table III.1 below lists the 20 projects and the RE&D and F&E costs for the communications resources of each.

Table III.1: FAA Communications Projects

Dollars in millions

Project	Cost
En Route	
Mode S	$7.5a
Voice Switching and Control System	786.0
Terminal	
Automatic Terminal Information Service Recorders	11.2
Integrated Communications Switching System	99.5
Tower Communications System	152.1
Transceiver Replacement	129.7
Flight Service Station	
Aeronautical Data Link	121.6
Hazardous In-Flight Weather Advisory Service	7.3
High Altitude En Route Flight Advisory Service and Expansion (two projects)	8.0
Communications Utilities	
Data Multiplexing Network	78.3
National Airspace Data Interchange Network IA	18.7
National Airspace Data Interchange Network II	50.6
Radio Communications Link	452.5
Radio Control Equipment	304.6
Other	
National Radio Communications System	82.4
Miscellaneous[b]	
Air-to-Ground Communication Radio Frequency Interference Elimination	65.2
Multichannel Voice Recorders	50.1
Communications Facility Consolidation	89.4
Sustaining Telecommunications Support	179.3
Total	**$2,694.0**

[a]Represents communications costs only. Estimated total cost for this project is $1.7 billion.

[b]These projects cannot be placed in any one category because they will be used in many or all service categories.

The projects in the first five categories either (1) provide resources to create new or expand existing communications services, or (2) replace obsolete and unreliable equipment used for some of the 63 communications services discussed in appendix II. Of the remaining four projects in the Miscellaneous category, two involve procuring equipment to be used in multiple service categories, and two are initiatives planned to allow FAA to better manage and support its communications services.

En Route Communications Projects

These projects are to assist in air traffic control functions at facilities such as air route traffic control centers and future consolidated area control facilities, which provide air-to-ground radio systems used for communication between controllers and pilots.

Mode S—Discrete Addressable Secondary Radar System With Data Link

The Mode S project has two objectives: (1) to replace existing secondary beacon radars at terminal and en route sites, and (2) to provide a digital data communications link. The second objective will involve establishing an air-to-ground, two-way data communications link between pilots and controllers. This component is to provide pilots with weather messages from the NAS weather data base and allow the exchange of data between pilots and controllers.

FAA plans to procure Mode S under two contracts. The first contract for 137 systems provides coverage to 12,500 feet and was awarded in 1984 to a joint venture of UNISYS and Westinghouse corporations. Implementation of these systems is now scheduled for fiscal year 1991 through 1994. The total estimated project cost for these 137 systems is $477.9 million. FAA officials estimate that $7.52 million of this amount is considered communications costs for the data link portion of these systems.

In October 1988 FAA decided to purchase 259 additional systems providing coverage down to 6,000 feet. FAA estimates the cost for these additional systems at over $1.2 billion. This brings the total estimated costs for this project to about $1.7 billion.

Voice Switching and Control System

This project is to develop and install FAA-owned switching equipment that will perform intercom, interphone, and air-to-ground voice connectivity and control functions needed for air traffic control operations in

air route traffic control centers and future consolidated control facilities. FAA plans to install switches at 22 air traffic control centers and area control facilities, the New York Terminal Radar Approach Control facility, the FAA Technical Center, and the FAA Training Academy. The first operational implementation of the Voice Switching and Control System is scheduled for 1992. FAA estimates total project costs at $786 million, of which $110.8 million was identified for research and development of the switches.

Terminal Communications Projects

FAA has four projects in the terminal communications area: Automatic Terminal Information Service Recorders, the Integrated Communications Switching System, the Tower Control System, and the Transceiver Replacement. These projects, which represent an estimated $392.5 million investment, are to assist in providing air traffic control functions and navigational aid service for arriving and departing aircraft. Facilities providing these services include terminal radar approach control facilities and airport traffic control towers that control aircraft in the airspace immediately surrounding airports, on the ground, and in the approach zones of airports.

Automatic Terminal Information Service Recorders

This project replaces older voice recorders that transmit weather and airport condition information to pilots in controlled terminal areas. The older recorders have experienced reliability problems and are therefore being replaced with more reliable solid-state recorders. According to FAA, solid-state recorders are cost beneficial because of minimal maintenance and reduced space requirements. Total estimated project cost is $11.2 million. Delivery of the new recorders began in 1988.

Integrated Communications Switching System

This project provides voice communication switching systems by replacing obsolete and no-longer-maintainable leased switches with FAA-owned switches at air traffic control facilities. These switches control intercom, interphone, and air-to-ground radio communications. There are three types of switches: type 1 for small air traffic control towers and smaller terminal radar approach control facilities, type 2 for larger terminal radar approach control facilities, and type 3 for other facilities.

Currently, FAA has purchased all type 1 switches and some type 2 switches. The remaining type 2 and type 3 switches are being purchased as funds are made available. Total project cost is estimated at $99.5 million.

Tower Communications System

This project provides modernized voice communications switches and control systems at air traffic control towers. FAA states the new equipment will improve operations and maintenance of the systems. This new equipment is planned to route voice communications between tower controllers, consolidated area control facility controllers, automated flight service station specialists, and air traffic control command center specialists. Approximately 237 systems will be procured and must interface with the Integrated Communications Switching System, Radio Control Equipment, and Voice Switching and Control System. Estimated total cost is $152.1 million. Delivery of the first five systems is scheduled for June 1992.

Transceiver Replacement

This project involves replacing old transceivers (radios) in terminal radar approach control facilities and towers. Two types of radios are being replaced: (1) portable emergency radios needed for controllers to continue to communicate with pilots when facilities are evacuated, and (2) back-up radios. This project is scheduled to begin implementation in 1991 with an estimated total project cost of $129.7 million.

Flight Service Station Communication Projects

The Aeronautical Data Link, Hazardous In-Flight Weather Advisory Service, and High Altitude En Route Flight Advisory Service projects are to assist in providing a wide range of advisory and support services. These include providing flight plan filing, preflight and in-flight weather briefings, and assistance to pilots in distress.

Aeronautical Data Link

This project, formerly called the Weather Communications Processor/Data Link, is to develop, evaluate, and implement a variety of weather and data link services for air traffic control. These services include providing weather information such as surface observations, terminal forecasts, and hazardous weather advisories to pilots when requested, and providing air traffic control services such as altitude confirmation and minimum safe altitude warning. The total estimated communications cost for this project is $121.61 million, which includes $55.49 million for research and development.

Hazardous In-Flight Weather Advisory Service

This project is to replace the 3-minute, single-tape transcribed weather broadcast service at selected flight service stations with single channel, solid-state, digital voice recorders that will continuously broadcast prerecorded weather advisories and statements of hazardous weather.

According to FAA, the new recorders will relieve air traffic controllers and flight service specialists from labor-intensive broadcasting tasks and improve the timeliness of information dissemination. Initially, this service will be implemented using existing leased voice lines; however, FAA plans to replace these leased lines with radio communications link channels as part of future consolidation efforts. Estimated total project cost is $7.3 million.

High Altitude En Route Flight Advisory Service and Expansion

The first project provides circuits that will transmit pilot reports and en route, real-time weather information from flight service stations to in-flight aircraft operating at or above 18,000 feet. The second project expands this service using the communications channels provided by the first project. The first project is estimated to cost $5.3 million of which $3.2 million has been obligated through fiscal year 1988. Procurement has just begun for the second project, which has an estimated total cost of $2.7 million.

Communications Utilities Projects

Communication utilities are systems that support multiple services or which comprise some form of network that connects facilities. These systems are the Data Multiplexing Network, National Airspace Data Interchange Networks IA and II, Radio Communications Link, and Radio Control Equipment projects.

Data Multiplexing Network

This network is an integral part of FAA's strategy for providing cost-effective interfacility communications transmission. FAA is procuring commercially available data multiplexing equipment that is to consolidate data from multiple low-speed communication lines and transmit the data over a single high-speed line. This equipment will serve air route traffic control centers, terminal radar approach control facilities, air traffic control towers, and flight service stations. The network, estimated to cost $78.3 million, is to provide telecommunications support for several new projects, and is being implemented in three phases:

- Phase I, which is complete, established a network by connecting 23 air route traffic control centers, 130 air route surveillance radars, the National Communications Center, the FAA Technical Center, and the Central Flow Control Facility at FAA headquarters. Using leased transmission circuits, Phase I transmits long-range radar data, interfacility data, traffic management system data, and related data to these facilities.

- Phase II, which is also complete, added equipment at 420 terminal facilities to the network established by Phase I. With this addition, the network carries interfacility data from air route traffic control centers to terminal facilities. Also, flight data input/output data, computer based instruction data, and remote maintenance monitoring systems data are being transmitted. Phase II is also utilizing leased circuits for transmission.
- Phase III is to expand and reconfigure the network by increasing capacity, expanding links to additional terminal facilities, and reconfiguring the existing network to use the FAA-owned radio communications link for transmission. Phase III implementation is projected for 1989 through 1994.

National Airspace Data Interchange Network IA

FAA is purchasing switches to establish a national message switching network to replace and combine a number of independent low-speed networks such as the United States-operated portion of the Aeronautical Fixed Telecommunications Network and the Automated Service B Data Interchange Service (see appendix II for descriptions of these services). According to FAA, this replacement and consolidation will improve operational effectiveness, reduce operational costs by reducing leased line requirements, and provide system interoperability and better management capabilities. In addition, the network will allow expansion to meet future requirements. According to FAA officials, implementation is approximately 99 percent complete with estimated project costs totaling $18.7 million.

The network transmits flight plan data among flight service stations, air route traffic control centers, military base operations, and international ports. It also provides switching for weather data for air route traffic control centers and FAA's host computers. The network is made up of two switching centers located in Atlanta, Georgia, and Salt Lake City, Utah, and 23 sites that link users to the switching centers.

National Airspace Data Interchange Network II

National Airspace Data Interchange Network II is a project to purchase switches that will build upon and expand the National Airspace Data Interchange Network IA to meet future communication needs. These switches are to establish a packet switching network to (1) expand data switching capability, (2) provide network monitoring functions, and (3) increase the capacity, flexibility, and service availability of the National Airspace Data Interchange Network IA.

This network is to provide switching for virtually all systems requiring interfacility data switching services, including systems currently on the National Airspace Data Interchange Network IA. The network connects 20 air route traffic control centers, the New York Terminal Radar Approach Control Facility, the FAA Technical Center, and the switching centers in Atlanta, Georgia, and Salt Lake City, Utah. FAA plans to utilize radio communication link channels for transmission. According to FAA officials, the network should be fully operational in the 1992-1995 time frame with total project cost estimated at $50.6 million.

Radio Communications Link

This two-phased project is to (1) replace equipment at 750 outdated radar microwave link sites which have become expensive to maintain, and (2) expand to 250 new sites to form a national microwave radio network. This network is to provide an integrated, analog transmission medium for current voice, data, and broadband radar traffic. The network is also to satisfy future requirements such as redundant and alternate rerouting capabilities. According to FAA, the radio communications link project will ensure reliable transmission of radar data, reduce costs of interfacility communications, and improve system availability while providing flexibility to accommodate future interfacility communication requirements. FAA officials estimate that 343 of approximately 1,000 sites are currently operational and installation of the remaining sites is expected to be completed in May 1991. FAA estimates it will need $452.5 million for the project.

Radio Control Equipment

This project is to replace existing equipment with solid-state digital and analog technology which, FAA states, will improve operational performance and reduce maintenance costs. The new equipment will perform radio channel signaling and control functions to support air-to-ground voice communications between voice switching equipment such as the Voice Switching and Control System and Integrated Communications Switching System. The equipment will pass voice and radio signals over telephone or radio communications link circuits. The project is also to provide remote radio control, remote environmental sensors and maintenance monitoring, and emergency back-up power. Equipment is planned to be implemented at 2,000 sites with estimated total project costs of $304.6 million.

Other Services Communications Project—National Radio Communications System

The National Radio Communications System is a voice and data radio communications system based on national security decision directives. The system connects FAA headquarters in Washington, D.C., regional offices, field facilities, the Department of Transportation, the Department of Defense, and local government agencies.

This system is to provide the minimum essential communication capability necessary to support FAA, Department of Transportation, and Department of Defense operations during a local, regional, or national emergency when common carrier operations fail. In addition, the system is to be available for maintenance purposes, aviation security, accident investigations, and other FAA activities. The system is being implemented in many phases, and is estimated to cost $82.4 million.

Phase I of the project, which is almost complete, will provide secure data communications capability for 39 systems at air route traffic control centers and regional offices that will carry classified flight plan information. Phase II of the project provides voice and data communications capability via a high-frequency band with or without security. FAA plans to install 49 systems at air route traffic control centers; regional offices; flight inspection offices; and in San Juan, Puerto Rico; Honolulu, Hawaii; and Anchorage, Alaska. According to FAA officials, 39 systems are currently operational and 10 systems are in the process of being installed.

Phase III of the project is the installation of a voice system that uses radio frequencies. This system, in addition to emergency uses, will be used daily to dispatch FAA maintenance personnel. This phase was completed in June 1989. Phase IV-A will provide for secure voice communications over public switched networks. FAA is responsible for the installation of secure telephone units that are being purchased by the National Security Agency. Estimated completion of this phase is December 1992.

Miscellaneous

Four miscellaneous projects do not fall into any one service category because the equipment or funding provided will be used in several categories. For example, the Air-to-Ground Communication Radio Frequency Interference Elimination and Multichannel Recorders projects are to improve operations at many FAA facilities. The Communications Facility Consolidation and Sustaining Telecommunications projects are FAA initiatives to provide better management and support of communications resources used by all services.

Air-To-Ground Communication Radio Frequency Interference Elimination

This project is to replace existing equipment that is technologically obsolete and no longer meets performance requirements. This equipment consists of radio receivers and associated devices such as antennae that provide voice communications between air traffic controllers and pilots. FAA states that this project will improve air-to-ground radio communication service with the installation of new, state-of-the-art equipment at selected remote communications facilities to improve operational performance and reduce frequency interference. The estimated project cost is $65.2 million.

Multichannel Voice Recorders

This project replaced existing voice recorders at air traffic control towers, flight service stations, air route traffic control centers, and future consolidated area control facilities. These recorders capture and retain all voice communications between air traffic controllers and pilots. These recordings are used to reconstruct communications involving any type of incident, such as crashes.

FAA maintains that the older recorders have reliability, maintenance, supply and support, and capacity problems. According to FAA, the new recorders will provide more channel capacity and have fewer supply and support problems since they are currently commercially available. Delivery of the new recorders was completed in May 1989. The total estimated cost for this project is $50.1 million.

Communications Facility Consolidation

This FAA initiative is to reduce the cost of operating radio communications facilities by reducing the number of buildings housing air-to-ground radio communications equipment. This is being accomplished by locating transmitters and receivers serving different types of control facilities in one FAA-owned building and decommissioning vacated buildings. The consolidated communication facilities will serve the combined needs of air traffic control and flight service stations, and is one step in FAA's program to provide a modern, solid-state, remote-monitored radio communications network. According to FAA, this consolidation will result in cost savings and cost avoidances by reducing land leases, maintenance, power consumption, and communications leased services. FAA estimates that this consolidation, which began in 1982, will require $89.4 million through the 1990s.

Sustaining Telecommunications Support

FAA has a strategic objective to reduce dependence on leased telecommunications in order to improve reliability, flexibility, and survivability, as well as to control and reduce costs. In accomplishing this objective, the agency has begun acquiring telecommunication facility projects and engineering services and equipment. The sustaining telecommunications support initiative establishes the funding necessary to provide follow-on support for these efforts to continue. For example, it will provide funding for the expansion of the Radio Communications Link, replacement of selected equipment no longer supported by vendors, and small projects that show a lease cost/benefit savings. This initiative began in fiscal year 1989 with an estimated total project cost of $179.3 million.

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